

DIMINUTION AND DEGRADATION OF ENVIRONMENTAL RESOURCES BY PREHISTORIC LAND USE ON POIKE PENINSULA, EASTER ISLAND (RAPA NUI)

Andreas Mieth* and Hans-Rudolf Bork

Ökologie-Zentrum, Universität Kiel, Olshausenstraße 40, D 24098 Kiel, Germany.

INTRODUCTION

Interactions between ancient environmental conditions, natural resources, prehistoric land use and culture on Rapa Nui have been much discussed since Bahn and Flenley published *Easter Island – Earth Island* in 1992. Investigations on prehistoric agriculture on Rapa Nui were intensified in the last decade (Stevenson and Haoa 1998; Stevenson et al. 1999, 2002; Wozniak 1999, 2001). The relationships between environmental resources, land use and the cultural development on Rapa Nui were recently summarized and discussed by Martinsson-Wallin (2002). Despite intensive research on Rapa Nui's prehistory, from a scientific point of view, "forgotten" areas on the island remain, for example Poike peninsula. It was commonly believed that Poike peninsula, as the oldest part of Rapa Nui, did not have importance for agriculture. Recent research by Mieth et al. (2002) in eastern Poike showed evidence of intensive agriculture and settlement in this area. Furthermore it was proved that in eastern Poike, at around AD 1280, a dramatic change of the ecosystem took place, accompanied by the expansion of agriculture. An ancient *Jubaea* palm forest was cleared within a short period of time with the aim to open the landscape in the downslope areas for new ceremonial places, dwellings and agriculture. Less than 200 years later the deforestation and the beginning of agriculture reached the upper slope of Maunga Puakatiki. Sheet erosion was the consequence. The cultivated soil was eroded first. The *ahu* and dwellings down-slope were buried by sediments. The prehistoric land use in eastern Poike ceased around AD 1400. Mieth et al. (2002) analyzed the total erosion of fertile soils, important for the cultivation of nutritious cultural plants, as well as the deposition of sediment in the dwellings, as the primary reasons for settlement abandonment from eastern Poike.

Further investigation should proceed with the objective of obtaining a more detailed knowledge about the dynamics of prehistoric environmental resources and agricultural land use on Poike peninsula in general. Was forest dominated by *Jubaea* palms and clearance of the forest with the goal to intensify and expand agriculture significant also for other parts of the peninsula? Could various types and phases of agriculture be differentiated chronologically? Was the development of land use and the change of landscape on Poike a synchronous process respecting different parts of the peninsula? Or could temporal phases for various areas be differentiated? Was prehistoric soil erosion a widespread phenomenon on Poike and, if yes, what consequences did soil erosion have for the culture and for the society?

INVESTIGATION SITES AND FOUR-DIMENSIONAL LANDSCAPE ANALYSIS

Intensive analysis of prehistoric soil conditions, sediments, vegetation and land-use characteristics was carried out in differ-

ent locations in the north-east, north-west and south-west sectors of Poike. This paper focuses on the investigation sites in the south-west of the peninsula (Figure 1). One soil profile with a length of 100.5 m was opened and investigated near an erosion escarpment on top of the southwestern cliff (Figures 2, 3). This profile marks the edge of badlands, characterized by reddish volcanic rock and sediments, which, due to erosion, are exposed in large areas, as is the case in eastern Poike near Cabo Cumming. Furthermore, two soil profiles were investigated at the base of the fossil cliff at the southwestern edge of Poike near Tongariki, at the walls of gullies carving the foot of the cliff. The soil profiles were investigated by stratigraphical analysis. The methodological steps are described by Bork et al. (1998) and in context with the recent investigations on Poike by Mieth et al. (2002). Radiocarbon-analyses were carried out at the Leibniz-Laboratory at the University of Kiel (KIA).

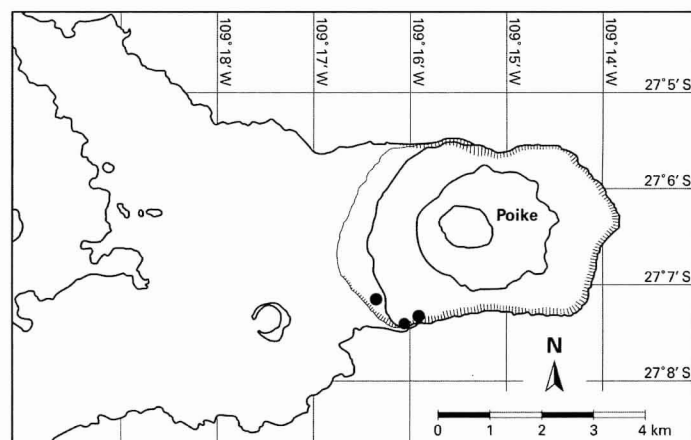


Figure 1. Poike with investigation sites in the south-west of the peninsula.

RECONSTRUCTION OF PREHISTORIC PALM VEGETATION AND ITS DESTRUCTION

The reconstruction of the prehistoric palm vegetation was carried out by analysis of the soil profile on top of the southwestern cliff of Poike. The length of the profile (100.5 m) allowed a representative insight into the geo-archive. At the base of this profile, reworked, reddish volcanic sediment is exposed. On top of the volcanic sediment a yellow-brownish soil with a clay content above 60 % and with a high content of kaolinite has developed. The undisturbed parts of the soil have a compact, polyedric structure. As proven by the soil profiles of eastern Poike, the 100.5 m profile in southwest Poike shows very clearly the root casts of palms. This palm is described by some authors as an extinct species of the genus *Jubaea* (e.g. Grau 2001). Others have defined the palm as *Paschalococcus dispersa* (e.g. Zizka 1991). As there is no final taxonomic evidence

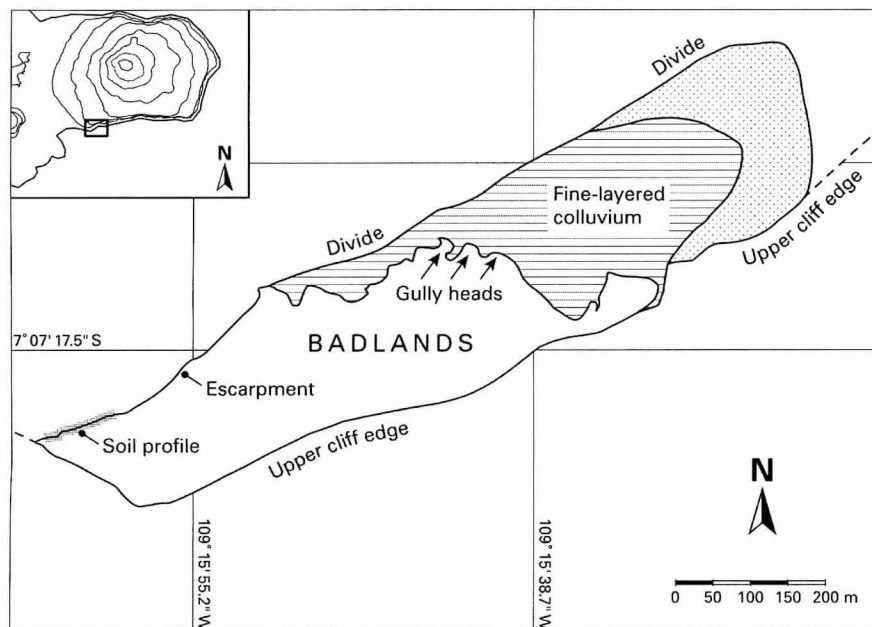


Figure 2. Catchment on the cliff top of south-west Poike with the location of the investigated soil profile and recent borders of the badlands and the fine-layered colluvium.



Figure 3. Erosion escarpment on the south western cliff top of Poike with the downslope section of the investigated soil profile.

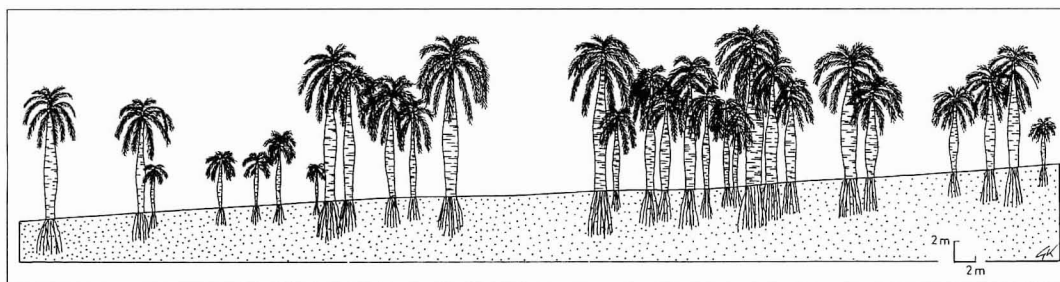


Figure 4. *Jubaia* palm forest on the cliff top in south-west Poike, reconstructed true-to-scale in a transect with a length of 100.5 meters.

(Dransfield et al. 1984), we use here the definition *Jubaia* sp. Un-branched root channels of these palms traverse the brownish soil mainly in the vertical direction and protrude downwards deeply into the reddish sediment. The diameter of

the root channels is between 4 and 7 mm, the total length of the roots often exceeds three meters. The cone-like root bulbs of the single palm individuals could be distinguished very clearly in the profile as the space between the individual palm root bulbs is free of root channels and the roots of the single palm individuals join at the upper edge of the former topsoil. The diameter of the root cones varies from 0.4 to 2.2 m. Twenty-nine single palm individuals were identified in the 100.5 m-profile. Based on the individually distinguished root marks, their distances, the different diameters of the root bulbs and the size of the related Chilean palm *Jubaia chilensis*, a true-to-scale-reconstruction of the ancient palm forest was established (Figure 4). This reconstruction shows a semi-open palm forest, which was possibly combined with grasses, herbal vegetation, bushes and other tree species of which there are no remnants. The distance of the palms varied. While some palms obviously grew in close proximity and stood in small groups, distances of up to 12.5 m were identified between other palm trees. An average distance of 3.5 m was calculated for the twenty-nine palm trees in the 100.5 m profile. The soil profile shows evidence for extended clearance of the palm forest. Above many of the root bulbs in the profile intensive enrichments of charcoal can be seen, remnants of burnt palm stumps. The charcoal of one palm stump was dated by ^{14}C analysis between AD 1309 and AD 1416 (calibrated age, probability 95.4 %; radiocarbon age: BP 573 \pm 20; KIA 18836). The lack of larger trunk remnants in the form of charcoal indicates that the fire in the palm forest was not a natural event but started by the Rapanui people who cut the trees and then burnt the unusable remains (slash and burn technique).

In some cases the burning of palm-stumps was obviously combined with the installation of *umu*. Above the roots of two close palms we found clearly marked layers of charcoal and burnt (reddish) clayey material with a total thickness of 0.3 m (Figure 5). Local disturbance of the layers indicates food withdrawal from the fireplace. Between the ligneous charcoal hundreds of needle like charcoal pieces with a length between 1.5 and 4 cm were found, identified as remnants of grass stalks of *Poaceae* (Figure 6). We can assume that dry grass was placed on the two

palm-stumps, probably with the aim to push the fire. The fine grass structure is exceptionally well preserved, as the grass did not burn completely due to lack of oxygen during the burning process as the fire was covered for cooking. The burnt grass



Figure 5. Burnt stump of an indigenous palm with indications for its use as *umu* and palm root channels below the fireplace

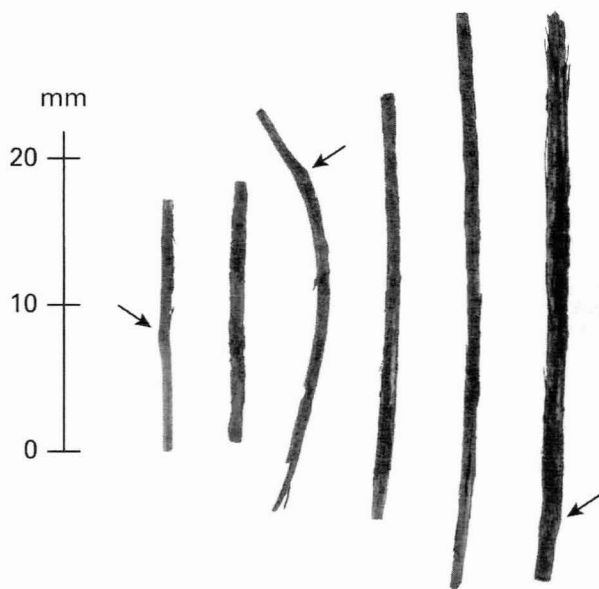


Figure 6. Carbonized stalks of grass (*Poaceae*); nodes marked by arrows.

was also dated by ^{14}C analysis. Its calibrated age is AD 1396–1438 (probability 86.8 %; radiocarbon age: BP 525 \pm 26; KIA 19369). The short life cycle of grass vegetation allows a very exact chronological determination of the fire event. The dating matches that of the charcoal of the palm-stump (KIA 18836). The use of grass in *umu* is also described by Orlicac (2000) and Orliac and Orliac (1998), but particularly for sites of a later period after the clearance of the palm forest.

PHASES OF PREHISTORIC LAND USE IN SOUTH-WEST POIKE BEFORE AND AFTER THE CLEARANCE OF THE PALM FOREST

Figure 7 summarizes the phases of land use and the development of the landscape in the southwestern cliff top area of Poike. Figure 7 E represents the recent investigated situation of the soil profile. The yellow-brownish soil between the palm remnants (root channels, palm-stumps) in this profile has been almost completely homogenized by cultivation. The cultivated

soil has a loose, subpolyedric structure due to the digging activity. Undisturbed soil with a more compact structure is restricted to small patches in the upslope part of the 100.5 m profile below the cultivation layer and here close to the palm locations. A few planting pits of various diameters and depths, filled with soil of very loose structure, can still be differentiated within this cultivation layer. Soil homogenization partly reaches into the volcanic sediment. In these cases reddish sediment is homogenized with the brownish soil in a few planting pits. The soil was homogenized also very close to the palm roots, but the palm root channels in the profile show no disturbance or destruction by the former digging activity. Charcoal in this layer is present, but scarce. The clear differentiation between the well-preserved palm root casts and the intensive homogenization of the soil between the palms demonstrates that this first generation of agriculture took place within the indigenous palm forest (Figure 7A) and lasted over many years. The area between the palms was used very intensively as demonstrated by digging activity close to the palm roots. Nevertheless, the advantage of the semi-open palm forest with its protecting functions against strong insolation, evaporation, wind and water erosion was respected and preserved in the first period of land use, which can be characterized as sustainable agro-forestry.

After the forest clearance around AD 1400 (Figure 7B) in the down-slope area above the southwestern cliff agriculture promptly came to an end. Charcoal in the first cultivation layer was dated to AD 1407 – 1448 (calibrated age, probability 95.4 %; radiocarbon age BP 482 \pm 26; KIA 18833). This might be an indication for land cultivation that continued for a short time after the forest clearance. Intensive or longer lasting soil cultivation in the down-slope section after the woodland clearance can be excluded, however, as it would have destroyed the structures of the palm remnants and fireplaces. Thus a break in the agricultural land use is evident. This is also demonstrated by a dark brown humic horizon that covers the first cultivation layer and the palm remnants. The humic horizon is particularly well developed in the down-slope section of the 100.5 m-profile. The development of humic horizon is further evidence of a period of some decades or a few centuries absence of agriculture and a resultant development of grassland (Figure 7C). Agriculture in this area experienced a later revival however as several digging structures in the humic horizon demonstrate, namely in the down-slope section of the profile. Clearly marked planting pits of different sizes (up to 40 cm in diameter and up to 50 cm in depth) and different shapes indicate a second phase of extensive agriculture which now took place in an open landscape and was spatially very limited within the down-slope area (Figure 7D). Some of the planting pits of this second farming generation protrude into the first cultivation layer. Several of the planting pits contain charcoal that obviously still was used as a fertilizer. The charcoal of one planting pit was dated to AD 1492 – 1600 (calibrated age, probability 76.3 %; radiocarbon age BP 319 \pm 21; KIA 18834). These dates led to the conclusion that the second phase of land use in the down-slope area of southwest Poike was established approximately 100 to maxi-

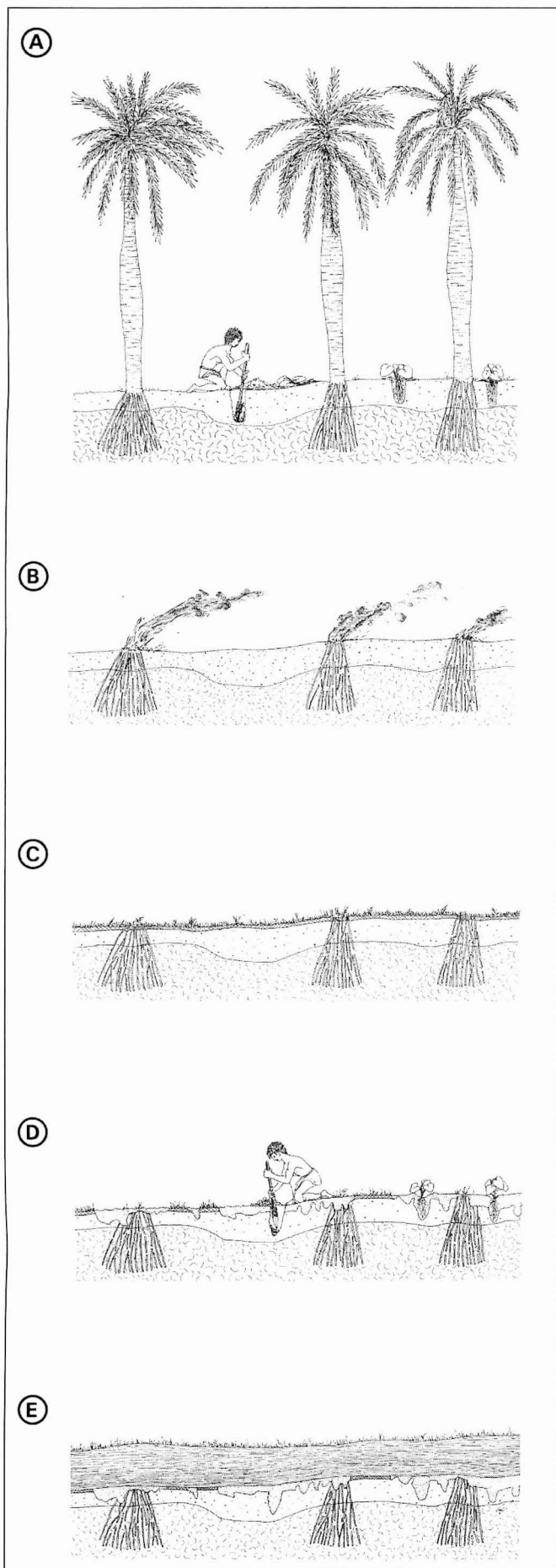


Figure 7. Phases of land use in the down slope area above the south western cliff of Poike peninsula, reconstructed for a section of the investigated 100.5 m-soil profile.

- A. Palm forest with intensive agriculture between the palms until c. AD 1400
- B. Clearance and burning of the palm forest at around AD 1400
- C. Development of a humic horizon in grassland after around AD 1400
- D. Clearly marked planting pits result from a second (extensive and short) period of agriculture between AD 1500 and AD 650
- E. Abandonment of agriculture and deposition of a fine-banded colluvium from the 17th century on.

200 years after the end of the first phase of agriculture and the clearance of the palm forest. Planting destroyed the grassland locally and enabled sheet erosion beginning first at the down-slope area above the cliff. Directly below the sheet erosion area the material was deposited in many fine bands producing a thicker colluvial layer. Once destabilized, the erosion area and the deposition of the colluvial layer migrated upslope. The colluvial layer has a maximum thickness of 1 meter and covers the described cultivation layers of the profile with more than 60 fine bandings in the vertical dimension (Figure 7E). Noting that the colluvial layer was deposited in a downslope- upslope sequence like tiles in a roof, caused by the upwards migrating sheet erosion, several thousand bandings can be differentiated in the longitudinal transect.

Charcoal is very scarce in the fine-banded colluvium and often reworked. One piece of charcoal, found in the fine-banded colluvium 5 cm below the recent land surface, was dated exactly to the time of woodland clearance (calibrated age: AD 1309 – 1419, probability 95.4 %; radiocarbon age BP 570 ± 22; KIA 18832). This indicates erosion of older charcoal. The lack of younger charcoal in the fine-banded sediment underlines that in southwest Poike after the 16th century no more wood existed and/or very few human fire activity took place. In the down-slope area there is no indication of human impact after the 16th century as the colluvium is undisturbed. The development of gullies and badlands in this area (Figure 2) was enabled by the grazing activity of sheep and cattle from the early 20th century onwards (Mieth and Bork 2003; Mieth et al. n.d.).

Two soil profiles at the base of the southwestern cliff of Poike, northeast of Ahu Tongariki, also prove evidence of phases of land use. Namely, the more northerly-located soil profile shows a very differentiated stratigraphy (Figure 8). Also at the base of this profile we found the brownish clayey soil with many root casts of *Jubaea* palms, evidence for the fact that the steeper slopes of Poike were also overgrown by palm forest. The upper layer of the brownish soil besides the palm roots is homogenized and loosened by cultivation. Agriculture on this steep slope is evidence for the very efficient land use in the palm forest. One planting pit with a depth of about 0.45 m contains very loose, dark soil material and charcoal, which probably was brought in as fertilizer. This charcoal was dated to AD 1309 – 1428 (calibrated age, probability 95.4 %; radiocarbon age BP 561 ± 26; KIA 18839). It is probable that the charcoal originates from the forest clearance in this area. This dating fits to the dating of the palm forest clearance around AD 1400 above the cliff. The first period of agriculture outlasted the forest clearance in this area presumably only a few years.

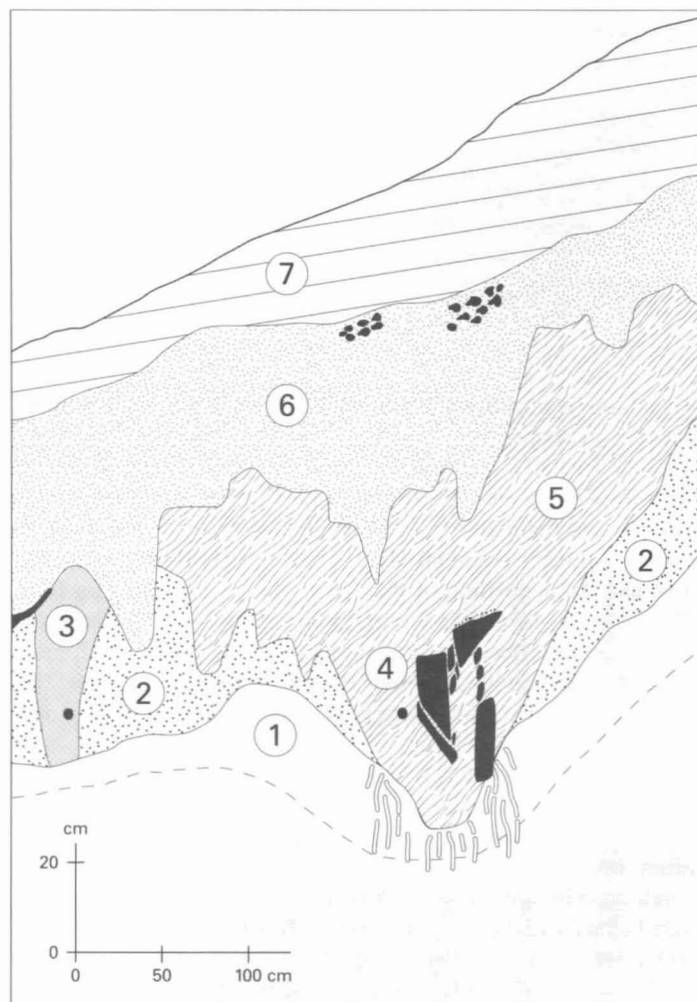


Figure 8. Soil profile (northern profile) at the cliff base in south-west Poike (2.5x super-elevation in scale)

1. Yellow-brownish soil with palm root channels
2. First cultivation layer
3. Planting pit with charcoal of forest clearing
4. Tomb (stone setting)
5. Fill of the tomb
6. Second cultivation layer
7. Fine-banded colluvial layer

Soil erosion was initiated on the cliff after the forest clearance. Brownish sediment at a thickness of about 0.35 m, originating from the B-horizon of the soil on the cliff, was deposited on the concave base of the cliff. The area was used then as a burial ground. About 1.4 m below the recent land surface a tomb construction was found in the profile consisting of a stone setting at its base and a fill above. The stone setting has a horizontal diameter of about 50 cm. The fill structure is approximately 1.3 m at its widest. The hole for the tomb was excavated to a depth of 1.2 m from the land surface at that time. The fill of the tomb contains several stones. Many stones are concentrated near the surface of the tomb fill, originating from a later destroyed stone layer that originally covered the fill. The fill contains also many charcoal pieces. The dating of one charcoal piece at the side of the stone setting (calibrated age AD 1331-1438, probability 95.4 %; radiocarbon age BP 626 ± 25; KIA 18840) likewise fits

to the time of the palm forest clearance. Obviously the charcoal from this time was mixed into the tomb fill by the intensive digging activity during its construction. The stone setting was found partly tumbled. Obviously it could not stand the weight of the sediment fill and therefore was compressed soon after its construction.

The sediment layer above the first agricultural horizon and the upper part of the tomb fill shows evidence of development of a humic horizon on the cliff and proves a later, second phase of farming in this area. Again the soil was loosened and homogenized by cultivation. The profile demonstrates clearly marked planting pits which protrude down into the first agricultural horizon and also into the tomb fill. The evidence of agriculture above the tomb allows the assumption that the people who cultivated the land at this time were unaware of the burial site; otherwise it would probably have been respected. This indicates that a time span of some generations existed between the first and the second phase of land use. Flakes of obsidian and many charcoal pieces were found in the second cultivation layer. Enrichments of charcoal are present in the planting pits and at the base of an *umu*, located at the edge of the profile. The *umu* contains numerous stones cracked by the fire, bone fragments and burnt clay material. The charcoal from the *umu* was dated to AD 1518 – 1652 (calibrated age, probability 95.4 %; radiocarbon age BP 297 ± 21; KIA 18841) and indicates that the second phase of land use was established 100 to 200 years after the first generation of farming on this site and hereby was synchronous to the second phase of agriculture above the cliff. Again soil erosion occurred, resulting from farming activity. In contrast to the numerous fine colluvial bandings in the profiles of the top area, the layered colluvium in this profile consists only of 5-10 single layers with an average thickness of 4 cm. Some of the layers are of a very grainy consistency and contain numerous rock fragments with a diameter of less than 20 cm. The material was eroded on the cliff where un-weathered rocks were exposed after the soil had been eroded. Charcoal is very scarce, indicating the lack of wood in this area from the 16th century onwards. Also in this location the Rapanui people did not reactivate agriculture. Grass vegetation covered the surface from the 16th, or at the latest, the early 17th century until the 20th century.

The recent gully was cut as a consequence of sheep farming since the early 20th century. The gully process slowed down in the last decades, evident by areas of undisturbed vegetation growing on the gully walls. The peak of the gully activity was during the period of very intensive sheep grazing on Poike, between 1930 and 1960 (Mieth et al. n.d.).

Figure 9 illustrates the southerly-located soil profile at the cliff base of the southwestern corner of Poike in a distance of about 700 m to the northern profile. In comparison to the northern profile the southern profile has no evidence of a first phase of agriculture in the 14th century. Palm root channels were not found here. An enrichment of fine powdered charcoal is present in a dark brown humic horizon. The dating of this charcoal (calibrated age AD 1473-1667, probability 92.5 %; radiocarbon age BP 298 ± 48; KIA 18842) matches well to the second phase of agricultural land use in the other investigated sites of south-west Poike. In this profile three main colluvial layers can be differentiated above the humic horizon (M1, M2 and M3 in Fig-

ure 9). M1 is a reddish to brownish, fine-banded colluvium. It is up to 0.20 m in thickness and of a clayey to sandy consistency. M2 is up to 0.40 m in thickness and consists of reddish

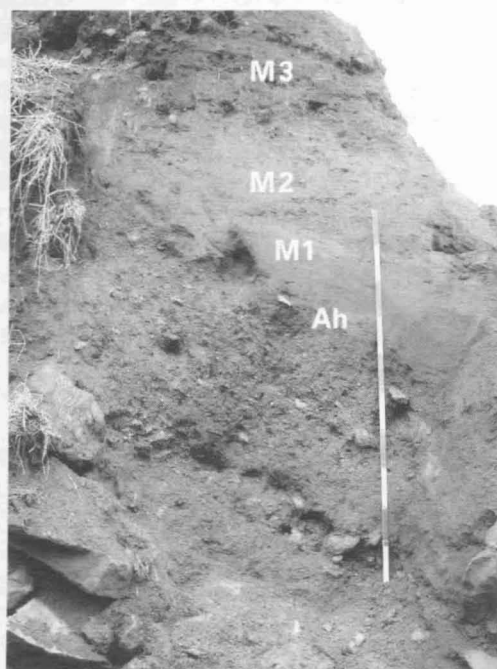


Figure 9. Soil profile (southern profile) at the cliff base in south-west Poike M1, M2 and M3 = colluvial layers.

sandy bandings with a few layers of small stones and fine bandings of powdered (reworked) charcoal. M3, the upper and youngest layer, is up to 0.20 m in thickness, reddish in color and of a sandy to stony consistency in its bandings. These colluvial layers also originate from soil erosion on the cliff. The total thickness of the colluvium is between 0.8 and 1.0 m.

DISCUSSION AND CONCLUSIONS

SPATIAL AND TEMPORAL SEQUENCE OF LAND USE ON POIKE PENINSULA

The results of the stratigraphical analysis of the soil profiles in eastern and southwestern Poike show many principal similarities. By physical remnants it is evident that Poike peninsula was once completely covered by a forest with the *Jubaea* palm as the predominant species. The ancient presence of palms, especially on Poike, was also mentioned by Love (cited in Bahn and Flenley 1992). Furthermore fossilized palm fruits were found mainly on Poike (e.g. in the cave Ana o Keke) and dated around AD 1130 (Flenley 1993). In addition to the palm root casts in the profiles of eastern and southwestern Poike, we also found root marks in the primeval soils of the northwest, the north and northeast of Poike. Marks of palm roots exist even in the top area of the volcano Maunga Pua Katiki. Considering the investigations of Orliac (2000), other species of bushes (as *Sophora toromiro*) and even several other tree species must have also grown within the palm forest. It is still not clear why only the root casts of the palms are preserved and not those of

other woody plants. Furthermore, by which chemical or physiological processes the root channels were preserved and why this obviously was only the case for the last generation of palms remains an unanswered question. However, the first settlers on Poike placed their garden pits within the palm-dominated forest, using the favorable climatic conditions under the tree canopy. But then the increasing importance of Poike as a place for settlement, as a location for religious ceremonies, as an area with important environmental resources such as wood and as a well-suited area for farming led to deforestation. The destruction of the palm forest on Poike happened in a short period of time. The earliest dating of charcoal from extended fires were found in the most eastern part of the peninsula near Cabo Cumming (Mieth et al. 2002). These dates indicate the beginning of forest clearance around AD 1280. In the southwestern part of Poike the forest was cleared 100 to 200 years later. Fire events occurred here between AD 1300 and AD 1450, most likely around AD 1400. From the northwest of Poike we have charcoal dating that indicate forest clearance around AD 1440. With respect to these physical evidences, the peninsula was deforested within a few human generations, probably during less than 200 years. Fire as a natural event in the palm forest can be excluded from many reasons: Charcoal from extended fires before human settlement was never identified on Rapa Nui. Furthermore there are no remnants of burnt trunks or stems older than AD 1280 on Poike. Moreover recent reviews have proved Rapa Nui's climatic situation as particularly constant (MacIntyre 2001). And finally, charcoal is most frequent in anthropogenic structures such as *umu*, planting pits and cultivation layers. After the woodland clearance, new settlements expanded on Poike, certainly a consequence of the growing population pressure on Rapa Nui in general. In eastern Poike *ahu*, tombs and dwellings were constructed immediately after the palm forest was cleared. It is probable that also in the southwestern part of the peninsula settlements were established following deforestation. While at the southwestern cliff base near Ahu Tongariki archaeological remnants such as *hare paenga* and *umu* are frequent, on the cliff top only a few archaeological structures are visible today. Some remnants of stone settings, for example, exist here in the grassland a few hundred meters west of the investigated 100.5 m soil profile on the southwestern cliff top. As is the case for the badlands near Cabo Cumming it is unknown how many structures were lost by erosion in the badlands of Poike's southwestern edge, or how many structures are still buried by the colluvial layers there.

While land use in the down-slope areas of eastern Poike was abandoned after AD 1400, in the down-slope area of southwest Poike a second period of land use occurred between AD 1500 and AD 1675. Farming activity now took place in open land. The planting pits from this time are very well preserved and clearly marked in the profiles and indicate hereby that the second period of farming was extensive. Knowledge of "good" soil treatment was lost shown by the low numbers of planting pits. Little wood was still available in this second period of land use as the presence of charcoal from this time demonstrates. The sources of wood after the main woodland clearance on Poike are not clear. Considering the physical dating, the clearance of the palm forest happened between 100 and 200 years before the second period of land use. But the assumed

scarceness of wood after the main clearance is more an indication for a maximum of 100 years between the two periods of agriculture. The charcoal samples from the described profiles with calibrated ages between AD 1500 and AD 1675 represent the last little wood resources, either from Poike peninsula or collected from other places nearby. Also Orliac (2000) found ligneous charcoal in various archaeological sites on Rapa Nui, dated to the mid 17th century. Wood was then replaced by grass as fuel. Orliac mentions that the later presence of ligneous charcoal in anthropogenic structures does not reveal the density of the plant cover at this time. Collecting of last wood relics by the Rapanui might have been very efficient. Nevertheless Orliac doubts the interpretation of Flenley (1993, 1998), who concludes from pollen analysis that woodland clearance on the island was complete by the late 15th century. Our results from Poike peninsula integrate completion of palm forest clearance just into this time. Considering the clear results from our stratigraphic analyses, we follow the hypothesis of a man-induced destruction of the vegetation. Our conclusions concerning the intensification of agriculture and the cultural development on Poike after the clearance of the palm forest between AD 1280 and AD 1440 likewise match exactly the phases of land use in other parts of Rapa Nui, for example investigated by Wozniak (2002) and Stevenson et al. (2002). Also these studies allow the interpretation of the distinct relationship between the clearance of the palm forest and the expansion of settlements and agriculture, especially in the upslope regions after AD 1250.

SOIL EROSION AS CONSEQUENCE OF PREHISTORIC LAND USE AND RELEASING FACTOR FOR CULTURAL CHANGES

Agriculture on Rapa Nui before deforestation was characterized by sustainable land use techniques. Farming and gardening took place under the rain and wind sheltering canopy of palms and other trees. Soil treatment by mulching techniques and protection of the vegetation cover resulted in a high surface roughness and a high aggregate stability. Thus water and wind erosion was avoided. This situation changed dramatically with the installation of agriculture in open land. In eastern Poike, sheet erosion, enabled by agriculture, began soon after the destruction of the palm forest. Over a period of several decades dwellings and *ahu* were buried by the deposition of a great number of fine sediment layers (Mieth et al. 2002). In the down-slope area of the southwestern edge of Poike the surface was stabilized after the forest clearance by grassland for about 100 to 200 years. During a second period of agriculture, probably between the late 16th and the early 17th centuries, the grass vegetation was destroyed locally by scattered planting activity and hereby the surface was exposed to rainfall and wind resulting in sheet erosion. After the initial destabilization of the surface the erosion area migrated upslope while the eroded material was deposited in fine bandings below the erosion area. The fine bandings in the colluvial layer above the cultivated soils demonstrate very clearly the diminution and degradation of the soil quality by the time of the erosion process. The proportion of organic matter in the colluvial layers diminishes distinctly from the oldest layers (lower located in the vertical line and in the longitudinal sequence) to the youngest layers (upper located in the vertical line and in the longitudinal sequence). While the lower colluvial layers repre-

sent the reworked cultivation layer of the soil eroded upslope, the upper layers originate from the C-horizons of the upslope soils. The differentiation is clearly visible in the bandings by their color, texture and structure. Based on ¹⁴C dating along a transect from the northwestern upslope segment of Maunga Pua Katiki to Cabo Cumming, it could be demonstrated, that sheet erosion, once released by open land farming after the woodland clearance, lasted hundreds of years and therefore much longer than the farming activity itself (Mieth et al. n.d.). After these dates, the upward-migrating sheet erosion reached the top of Maunga Puakatiki at the beginning of the 20th century which is probably 400 to 500 years after agriculture had ceased on Poike. The average deposition rate of the colluvium along this transect totaled 8.6 tons per hectare per year (Mieth et al. n.d.). These dates underscore the long lasting and severe consequence of the relatively quick change from a sustainable system of agroforestry to the deforested landscape with agriculture in open land in the 13th / 14th centuries.

While the consequences of the later period of the prehistoric agriculture on Poike extend into the very recent time, farming areas of the Rapanui people and suitable soil conditions for their agriculture must have been destroyed in certain slope segments within a short period of time. The investigations on Poike show that the loss of soils and of soil fertility after the extended forest clearance in the 13th / 14th centuries very probably was the main reason for a dramatically reduced soil fertility and thus for the abandonment of settlements, ceremonial places, gardens and fields. In the geo-archives we can read about the few attempts of later agriculture in the 16th / 17th centuries and then the total abandonment of land use. Can the results of Poike peninsula be transferred to Rapa Nui in general? We suppose they can, and will investigate this question in the near future. We hypothesize that degradation of soil conditions and diminution of the environmental resources after the woodland clearance was a key factor releasing the breakdown of the balanced society and for the radical turn from the stone-based ancestor cult to the more competitive and destructive elements in the way of life. Why did this turn against traditional knowledge, experience and taboos occur? Was the more than 500-year success of sustainable land use itself, expressed by the consequent growth of the population and the development of the unique megalithic culture, the reason for the self-destruction of the social and environmental system? Was this initial success the beginning of the end as the land use resulted in an exponentially growing demand for farming areas and living places in a limited and isolated area? Or, were later influences coming however from outside with new agricultural techniques, new cultural plants as *kumara* (as argued for example by Stevenson et al. 2002) or with new social ideals the reason for the dramatic shift in the way of land use? Some of these questions will probably remain unanswered.

ACKNOWLEDGEMENTS

We are grateful to the people of Rapa Nui for their friendship, hospitality and support of our research. We thank the Consejo de Monumentos Nacionales de Chile, the Gobernador Provincial de Isla de Pascua Enrique Pakarati and the Corporación Nacional Forestal (CONAF) for granting us the permits and their

supports for our investigations. Thanks to Piet Grootes and his team in the Leibniz-Laboratory, University of Kiel, Germany, who carried out the radiocarbon dating. Illustrations were drawn by Doris Kramer and Gerd Klose. We profited much by discussions with Helene Martinsson-Wallin, Grant McCall, Stephanie Pauly, Karlo Huke Atán, José Miguel Ramírez, Christopher Stevenson, Gerardo Velasco, Francisco Torres Hochstetter and many others.

* Corresponding author: mieth@ecology.uni-kiel.de

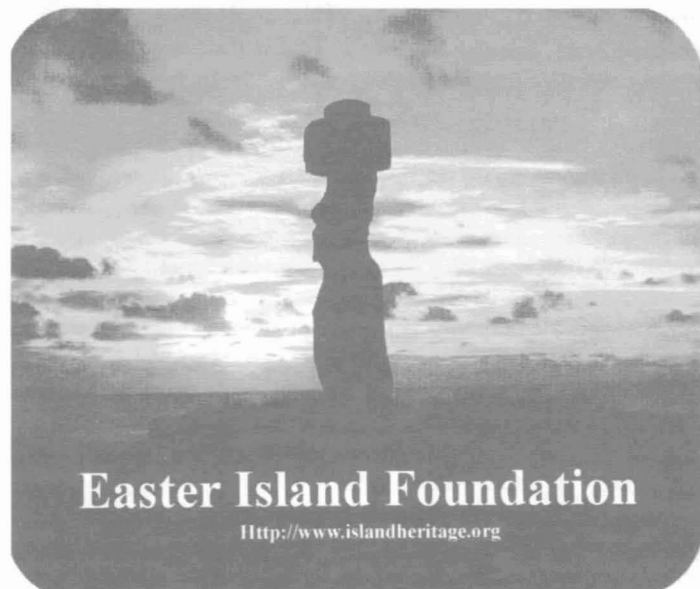
REFERENCES

- Bahn, P. and J. Flenley. 1992. *Easter Island – Earth Island*. Thames and Hudson Ltd., London.
- Bork, H.-R., H. Bork, C. Dalchow, B. Faust, H.-P. Piorr and T. Schatz. 1998. *Landschaftsentwicklung in Mitteleuropa*. Klett-Perthes, Gotha und Stuttgart.
- Dransfield, J., J. R. Flenley, S. M. King, D. D. Harkness and S. Rapu. 1984. A Recently Extinct Palm from Easter Island. *Nature* 312:750-752
- Flenley, J. R. 1993. The Palaeoecology of Easter Island, and Its Ecological Disaster. *Easter Island Studies. Contributions to the History of Rapanui in Memory of William T. Mulloy*. S. R. Fischer, ed. :27-45
- Flenley, J. R. 1998. New Data and New Thoughts About Rapa Nui. *Easter Island in Pacific Context. South Seas Symposium. Proceedings of the Fourth International Conference on Easter Island and East Polynesia*. :125-128. Easter Island Foundation, Los Osos.
- Grau, J. 2001. More about Jubaea Chilensis in Easter Island. *Pacific 2000. Proceedings of the Fifth International Conference on Easter Island and the Pacific*. C. M. Stevenson, G. Lee and F. J. Morin, eds. :87-90. Easter Island Foundation, Los Osos.
- MacIntyre, F. 2001. Enso, Climate Variability, and the Rapa Nui, Part II. Oceanography and Rapa Nui. *Rapa Nui Journal* 15(2):83-94
- Martinsson-Wallin, H. 2002. Sea, Land, and Sky as Structuring Principles in Easter Island Prehistory. *Rapa Nui Journal* 16(2):74-76
- Mieth, A. and H.-R. Bork. (2003). Land Degradation on Easter Island, Southern Pacific. Paper presented on the 2nd International Symposium on Gully Erosion under Global Change, Chengdu. (in press)
- Mieth, A., H.-R. Bork and I. Feeser. 2002. Prehistoric and Recent Land Use Effects on Poike Peninsula, Easter Island (Rapa Nui). *Rapa Nui Journal* 16(2):89-95
- Mieth, A., H.-R. Bork and W. Markgraf. (n.d.). History, Origin and Extent of Soil Erosion on Easter Island (Rapa Nui). (submitted to Catena, special issue)
- Orliac, C. 2000. The Woody Vegetation of Easter Island Between the early 14th and the Mid-17th Centuries AD. *Easter Island Archaeology. Research on Early Rapanui Culture*. C. M. Stevenson and W. S. Ayres eds. :211-220. Easter Island Foundation, Los Osos.
- Orliac, C. and M. Orliac. 1998. The Disappearance of Easter Island's Forest: Over-exploitation or Climatic Catastrophe? *Easter Island in Pacific Context. South Seas Symposium. Proceedings of the Fourth International Conference on Easter Island and East Polynesia*. :129-134. Easter Island Foundation, Los Osos.
- Stevenson, C. M. and S. Haoa. 1998. Prehistoric Gardening Systems and Agricultural Intensification in the La Pérouse Area of Easter Island. *Easter Island in Pacific Context, South Seas Symposium. Proceedings of the Fourth International Conference on Easter Island and East Polynesia*. C. M. Stevenson, G. Lee and F. J. Morin, eds. :205-213. Easter Island Foundation, Los Osos.
- Stevenson, C. M., J. Wozniak and S. Haoa. 1999. Prehistoric Agricultural Production on Rapa Nui. *Antiquity* 73:801-812
- Stevenson, C. M., T. Ladefoged and S. Haoa. 2002. Productive Strategies in an Uncertain Environment: Prehistoric Agriculture on Easter Island. *Rapa Nui Journal* 16(1):17-22
- Wozniak, J. A. 1999. Prehistoric Horticultural Practices on Easter Island: Lithic Mulched Gardens and Field Systems. *Rapa Nui Journal* 13(3):95-99
- Wozniak, J. A. 2001. Landscapes of Food Production on Easter Island: Successful Subsistence Strategies. *Pacific 2000. Proceedings of the Fifth International Conference on Easter Island and the Pacific*. C. M. Stevenson, G. Lee and F. J. Morin, eds. :91-102. Easter Island Foundation, Los Osos.
- Zizka, G. 1991. *Flowering Plants of Easter Island*. Palmengarten, Frankfurt a. Main.

HAUMAKA TOURS

Ramón EDMUNDS and Josefina NAHOE
Correo Isla de Pascua
RAPA NUI, Chile

e-mail: haumaka@entelchile.net
voicemail/fax for USA and Canada: (310) 754-6000 x1548
phone/fax on Rapa Nui: (011-56-32) 100-274



Easter Island Foundation

[Http://www.islandheritage.org](http://www.islandheritage.org)

New from the EIF! Mouse pads with a beautiful full-color image from our beloved island. Available only from us! 9 1/4 x 7 3/4 inches. \$10 plus postage. Class up your desk! Call or email your order: <rapanuibooks@att.net> or phone: (805) 528-8558.